Which factors drive successful BCI skill learning?

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Introduction

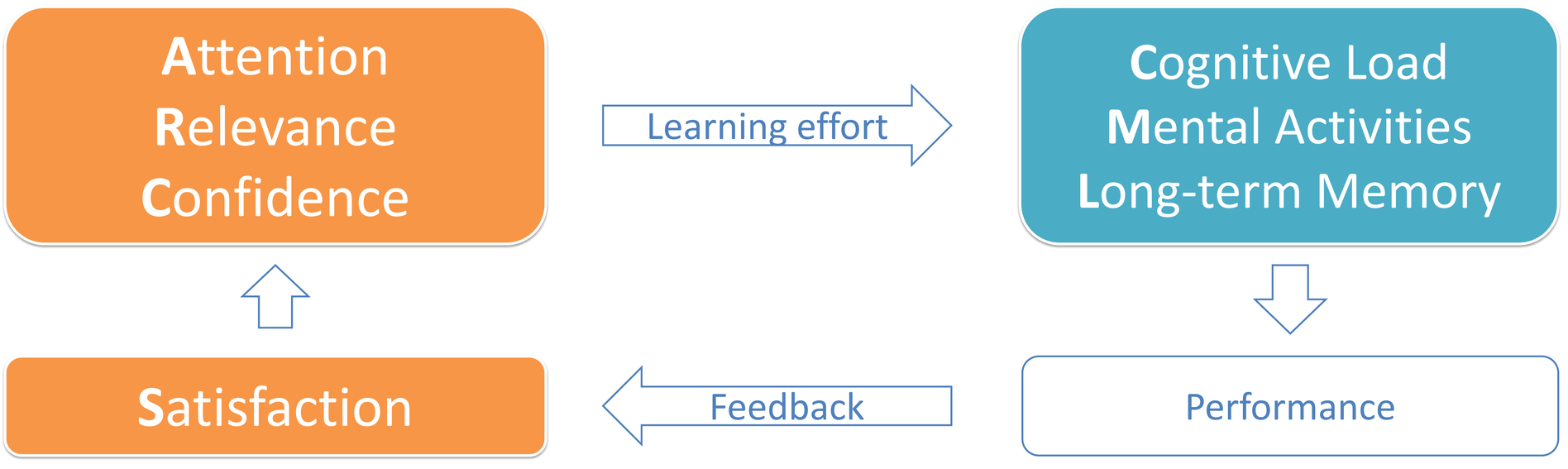
- Solving the **poor reliability of current BCI** requires new research directions, other than signal processing alone
- **Optimizing BCI training protocols** so that users can **learn BCI control mastery** could be one of them [2]
- This poster presents a set of **factors which could influence the learning process**, and thus could be considered to improve BCI performance of BCI
- These factors are based on Keller's theory of motivation, volition and performance [1]

Motivational Factors

.. lead to more user efforts and thereby a better (learning) performance.

Cognitive Factors

..optimize the way the learner processes information and thus how well he acquires the target skill.



Attention, a person's curiosity and focus, can be guided by perceptual/intellectual arousal, and the variation of stimulation.

- *Increase perceptual arousal by stimulation characteristics*
- *Increase inquiry arousal by task characteristics*
- *Vary stimulation to maintain attention*

Confidence, a positive expectancy for success, depends on the learner's initial mind-set and (the attribution of) success/failure.

- *Present clear performance requirements*
- *Enable success opportunities*
- *Enable feeling of personal control*

Relevance, the perceived value of the to-be-learned skill, depends on its compliance with a person's motives or values.

- *Emphasize the goal in instruction and feedback*
- *Match instructions to the learner's motives and learning style*
- *Increase the familiarity of the learning problem*

Satisfaction, about accomplishments and learning experience, helps to maintain motivation for current and future efforts.

- *Intrinsic rewards by enjoyment of the learning experience*
- *Extrinsic rewards by positive and motivational feedback*
- *Maintain equity with consistent standards and consequences for success*

Cognitive load, the burden on the limited resources of working memory, can be reduced regarding the instruction and presentation of information.

- *Limit extraneous (i.e., task-unrelated) load via instruction/ presentation*
- *Promote germane (i.e., task-related) load by support of learning strategies*
- *Use different sensory modalities to complement information*

Mental activities refer to the fact that humans are not passively receiving information, they actively process it (selection, organization and matching to prior knowledge), based on its relevance and saliency.

- *Make relevant information salient*

Long-term memory is providing prior knowledge and acquired skills for the organization and integration of the learned information.

- *Match to-be-learned to prior knowledge and skills*

Challenges and open questions

- Is BCI control similar to any other learning or performance task?
- Which other components we may need to be considered in BCI?
- Do these factors apply to BCI as well?
- How to manipulate those factors in BCI?

Conclusion: While often ignored, motivational and cognitive factors may positively impact BCI performances

References

1. Keller, *"An Integrative Theory of Motivation, Volition, and Performance"*. Tech., Instr., Cog. & Learning, 6(2), 2008
2. Lotte, Larrue, Mühl, *"Flaws in current human training protocols for spontaneous BCI: lessons learned from instructional design"*, Frontiers in Human Neurosciences, vol 7., no. 568, 2013